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Aberdeen Proving Ground, Maryland 21010

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TECHNICAL REPORT ARCSL-SP-83020

CIVIL DISTURBANCE COUNTERMEASURES—CHEMICAL

by

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June 1983



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This report contains a summary of the chemical, physical, and physiological characteristics of the riot control agents (CS and CR). It also provides a brief description and current status of the various riot control items, both in the inventory and in development, that employ these agents.		

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PREFACE

Chemical Systems Laboratory, US Army Armament Research and Development Command, is the agency responsible for the research, development, engineering, and initial production of riot control agents and materiel for the control of civil disturbances. The agents and devices described in this report are those of minimal hazard and are categorized as follows:

- (1) Riot Control Agents,
- (2) Standard US Army Riot Control Items, and
- (3) Other US Army Riot Control Items in the inventory.

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NOTE: Logistic Control Code (LCC) - A is Standard A.
 Logistic Control Code (LCC) - B is Standard B.
 Logistic Control Code (LCC) - F is Mission Essential, Contingency.

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SECTION I. RIOT CONTROL AGENTS

- A. Riot Control Agent CS, CS1, CS2**
- B. Riot Control Agent CR**

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A. RIOT CONTROL AGENT CS

Agent CS is orthochlorobenzal malononitrile, a white-to-yellow crystalline powder prepared as the condensation product of orthochlorobenzaldehyde with malononitrile or the condensation product of orthochlorobenzaldehyde with cyanoacetamide and subsequent dehydration. It should begin melting at 93°C and be completely melted at no greater temperature than 96.5°C. CS has a pungent pepper-like odor that is immediately detectable by the senses. It can be disseminated as a smoke or mist from pyrotechnic devices, and it is normally nonpersistent. CS is stable in storage in all climates. It may be put into gelatin capsules for use as a training aid. Agent CS may also be dissolved in a liquid for use in liquid dispersers. It is only sparingly soluble in water or ethanol, but readily soluble in methylene chloride.

The physiological and physical properties of CS-type agents make their use particularly effective for immediate temporary incapacitation of unmasked personnel. CS produces immediate effects even in low concentration. The median effective incapacitating concentration which produces respiratory effects is 10 to 20 mg/cu m; the concentration producing eye effects is 1 to 5 mg/cu m. The onset of incapacitation is 20 to 60 seconds, and the duration of effects is 5 to 10 minutes after the affected individual is removed to fresh air. During this time, affected individuals are incapable of effective concerted action. The physiological effects of low concentrations include extreme burning of the eyes accompanied by a copious flow of tears; coughing, difficulty in breathing, and chest tightness; involuntary closing of the eyes; stinging sensation of moist skin; runny nose; and dizziness or swimming of the head. Particle size, concentration, and local weather conditions, rather than duration of exposure, determine the effectiveness of CS.

Riot control agent CS exists as a family of three forms: CS, CS1, and CS2. The agent symbol "CS" identifies the agent in pure crystalline form when it is used in pyrotechnic munitions and is dispersed by thermal means to create an aerosol. The symbols "CS1" and "CS2" identify mixtures of the crystalline agent and an aerogel. Only CS1 is presently being used in bursting-type munitions and in bulk riot control agent dispersers.

Agent CS1 consists of 95% CS blended with 5% silica aerogel micropulverized (3- to 10-micron size) to achieve the desired respiratory effects when dispersed as a solid. The aerogel reduces agglomeration. The effectiveness of CS1 on open terrain under normal weather conditions lasts approximately 14 days. Agent CS1 has a low bulk density and may be dispersed by explosive dissemination devices, crop dusting-type blower devices, helicopter dispersers, and impact dissemination devices such as bombs.

Agent CS2 consists of 95% CS micronized (3- to 10-micron size) and then blended with 5% silicone-treated aerogel. The silicone-treated aerogel (made by tumbling 80% aerogel with 20% hexamethyldisilazane) serves not only to prevent agglomeration and increase flowability but also to markedly increase hydrophobicity which prolongs the effectiveness of the agent in terrain-denial applications. Of particular importance are the phenomena created by the silicone coating. The flow rate and persistence of the agent are increased. The powdered agent settles and readily infiltrates terrain, vegetation, personnel, and equipment. It floats on water. When the CS2 is disturbed, it is reaerosolized in the desired particle size to cause desired respiratory effects. Its

effectiveness on open terrain under normal weather conditions lasts approximately 30 days. CS2 has been used for tactical applications. The US Army Surgeon General has not approved CS2 as a training agent or riot control agent.

CS, as opposed to CS1 and CS2, is not considered a persistent-effect agent. Area decontamination is not required. Showering and changing of clothing are the only personnel decontamination procedures normally required. In the operation of some items or devices containing CS, the use of a protective mask is recommended; this recommendation is indicated in the operator's manual.

B. RIOT CONTROL AGENT CR

Agent CR is dibenz (b,f)-1:4-oxazepine, a yellow crystalline solid which is another highly irritant compound similar to CS in respect to both its effects and its safety. It differs from CS, however, in that it is more potent as an irritant and, although only sparingly water soluble, it is chemically stable in organic solutions (ethylene or propylene glycol), and so it remains active for a much longer time. CR may thus be used as an aerosol, when its effects will be similar to those produced by CS smoke, or in solution, when it may be directed with accuracy against small groups of rioters or even individuals. In solution, CR is found to be irritant at concentrations down to 0.0025% or even lower. The structures affected by liquid contamination are eyes, skin, mouth, and nasal cavity. CR has a melting range between 67° and 74°C. Currently, CR is being used only in solution for dissemination in liquid dispersers and, as such, its effectiveness is primarily in the eyes.

Riot control agent CR solution consists of 0.1% CR dissolved in a solution of 80 parts of propylene glycol and 20 parts of water. This solution has been approved by The Surgeon General of the US Army for use on personnel in riot situations.

Riot control agent CR is similar to the riot control agent CS with respect to toxicity and physiological effects. CR differs from CS in that CR skin effects are more pronounced and longer lasting and may make the skin very sensitive (for hours or days) when rubbed or washed. In this effect it is similar to a mild burn without the redness of a burn. It is also more persistent in the environment and on clothing since it is not broken down by water (hydrolyzed) as is CS. With CR, development of an allergy is less likely than for CS, but it does occur occasionally. Inhalation toxicity of CR is less than that of CS, and there is a moderate irritation of the lower respiratory tract with a resulting feeling of suffocation, coughing, and chest pain. CR causes a burning sensation and tearing of the eyes and also irritation of the nose and throat. The respiratory effects disappear within a few minutes after the individual is removed to an agent-free atmosphere.

**SECTION II: US ARMY STANDARD RIOT CONTROL ITEMS (LOGISTIC
CONTROL CODE A)**

- A. Disperser, Riot Control Agent, Helicopter- or Vehicle-Mounted, M5**
- B. Disperser, Riot Control Agent, Portable, M33A1**
- C. Disperser and Riot Control Agent, Manually Carried, CR, M36**
- D. Grenade, Hand, Riot, CS, M47**
- E. Riot Control Munitions System, 64 mm (Launcher, Projectile, 64 mm, Riot Control, M234; Projectile, 64 mm, Riot Control, Kinetic Energy, M743 with Cartridge/M755; and Projectile, 64 mm, Riot Control, CS, M742 with Cartridge/M755)**
- F. Grenade, Hand, Tactical, CS, M7A3**
(Note: M7A3 was originally a riot control grenade, but since 1974, it has been restricted to tactical use only.)

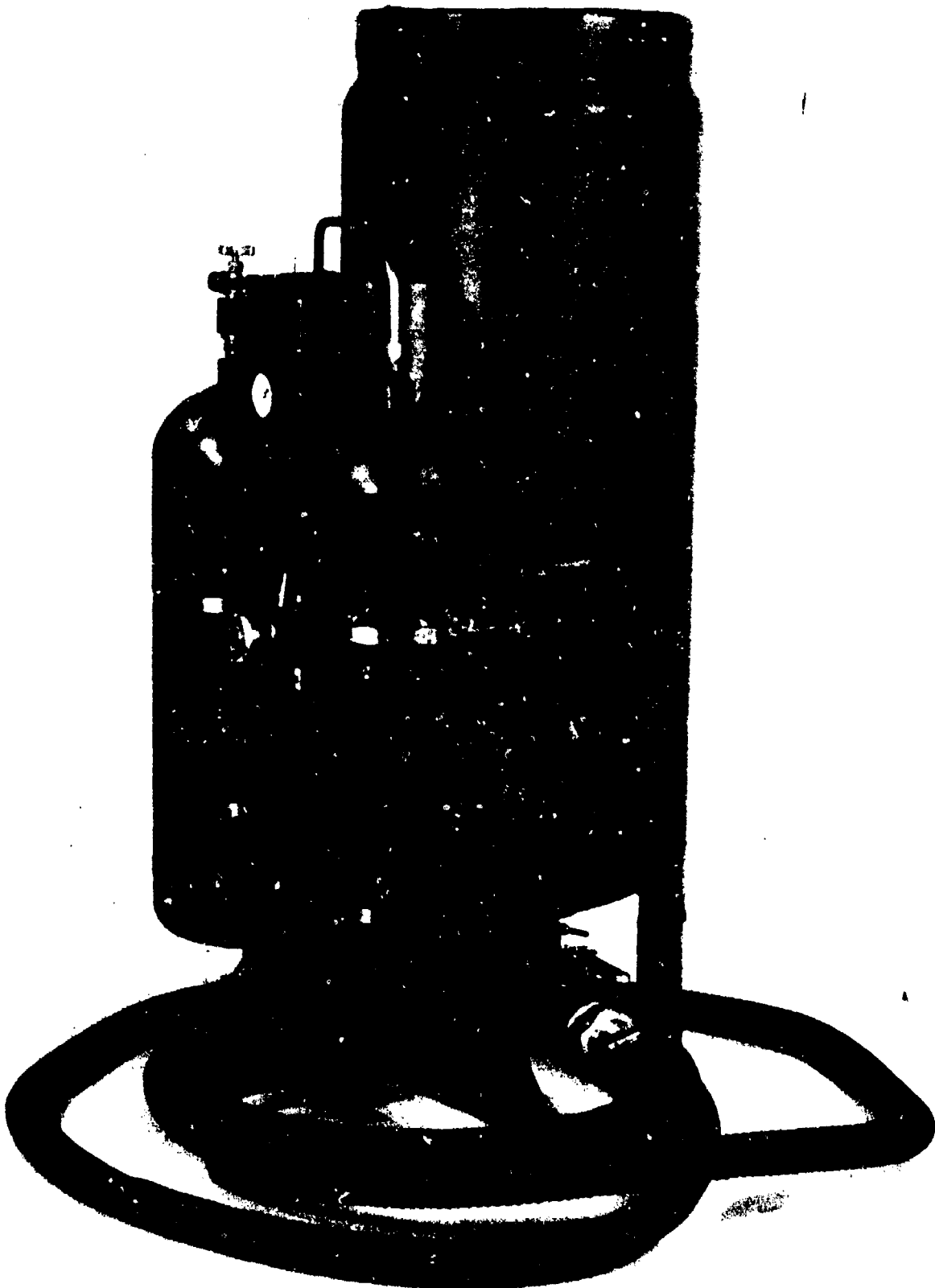


Figure 1. Dispenser, Riot Control Agent Helicopter- or Vehicle-Mounted, M5

A. DISPERSER, RIOT CONTROL AGENT, HELICOPTER- OR VEHICLE-MOUNTED, M5

Use: The M5 helicopter- or vehicle-mounted riot control agent disperser is used to disperse powdered riot control agent CS1 into the atmosphere from either a low-flying cargo helicopter or a moving ground vehicle. NOTE: The M5 is a product improvement of the M4 disperser; see Section III.

Description: The M5 helicopter- or vehicle-mounted riot control agent disperser consists of an agent container tank, two air cylinders, a tubular aluminum frame, an M9 gun with a 12-foot hose for vehicle mounting, a 12-foot discharge hose for helicopter mounting, and various controls and instruments. An additional agent container tank is provided for refill purposes. Fittings and hold-down straps are provided for securing the disperser in a helicopter or ground vehicle. The disperser can be filled with 50 pounds of CS1 which can be released in 2 minutes of continuous operation from the M9 gun or in 20 seconds from the helicopter hose. The range of the gun is 40 feet in still air.

Status: Type Classified - Standard; Logistic Control Code A; Stockpiled.

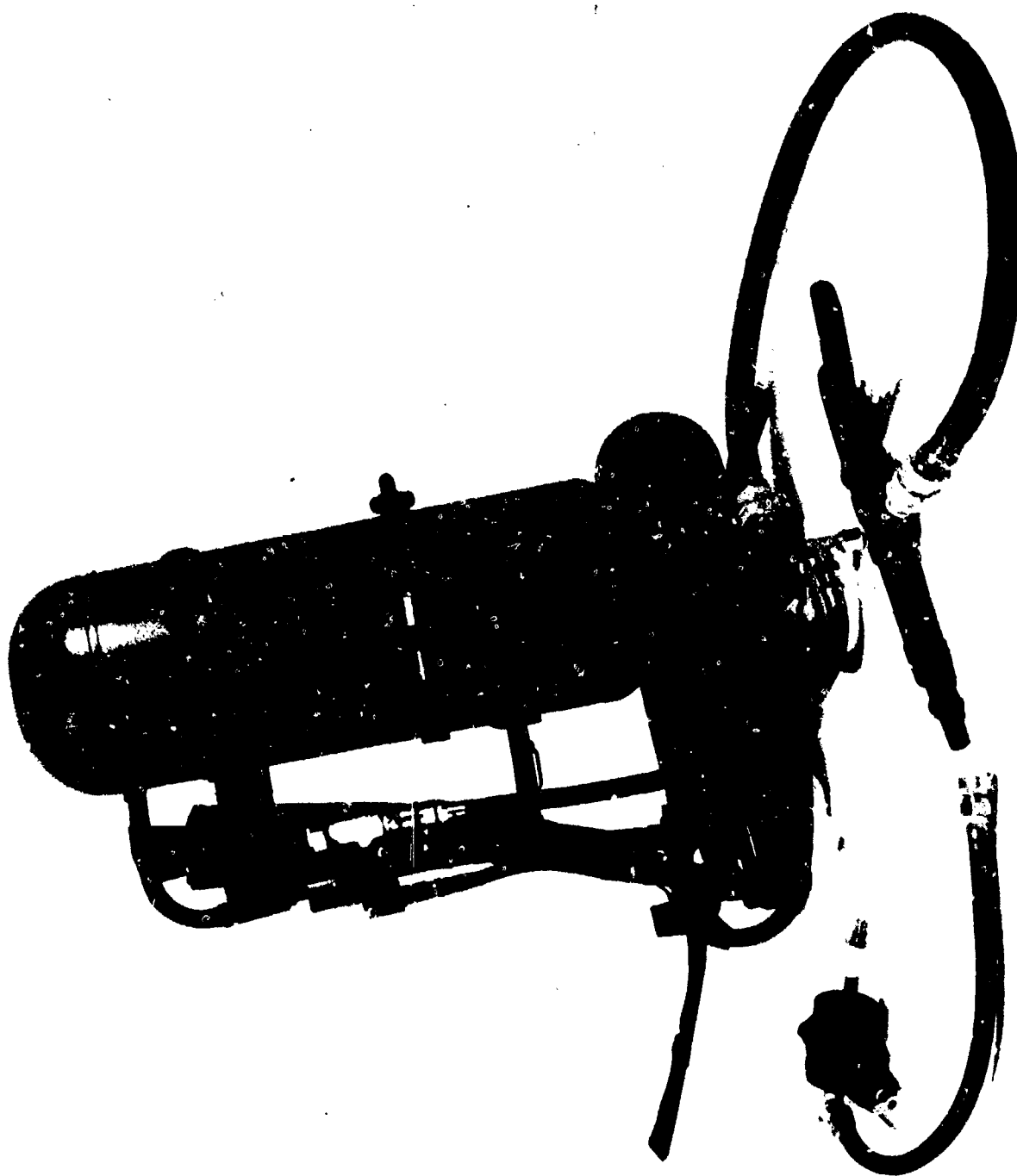


Figure 2. Disperser, Riot Control Agent, Portable, M33A1

B. DISPERSER, RIOT CONTROL AGENT, PORTABLE, M33A1

Use: The dispenser is used to discharge liquid CR or dry CS; powdered riot control agent into the atmosphere or on personnel to control uprisings, disturbances, and riots.

Description: The M33A1 dispenser consists of a frame and harness assembly, an agent container assembly, an air-pressure assembly, and a gun and hose assembly. The frame and harness assembly provides the means for the operator to carry the dispenser. The agent container assembly holds the supply of agent. The air-pressure assembly stores and supplies the pressurized air to drive the agent from the agent container. The gun and hose assembly directs the discharge of the agent toward the target. The dispenser can be filled with 3 gallons of CR solution or 8 pounds of dry CS1. These fills can be released in 60 seconds (CR) or 40 seconds (CS1) of continuous operation. Range of the gun is 40 feet in still air.

Status: Type Classified -- Standard; Logistic Control Code A; currently in production.

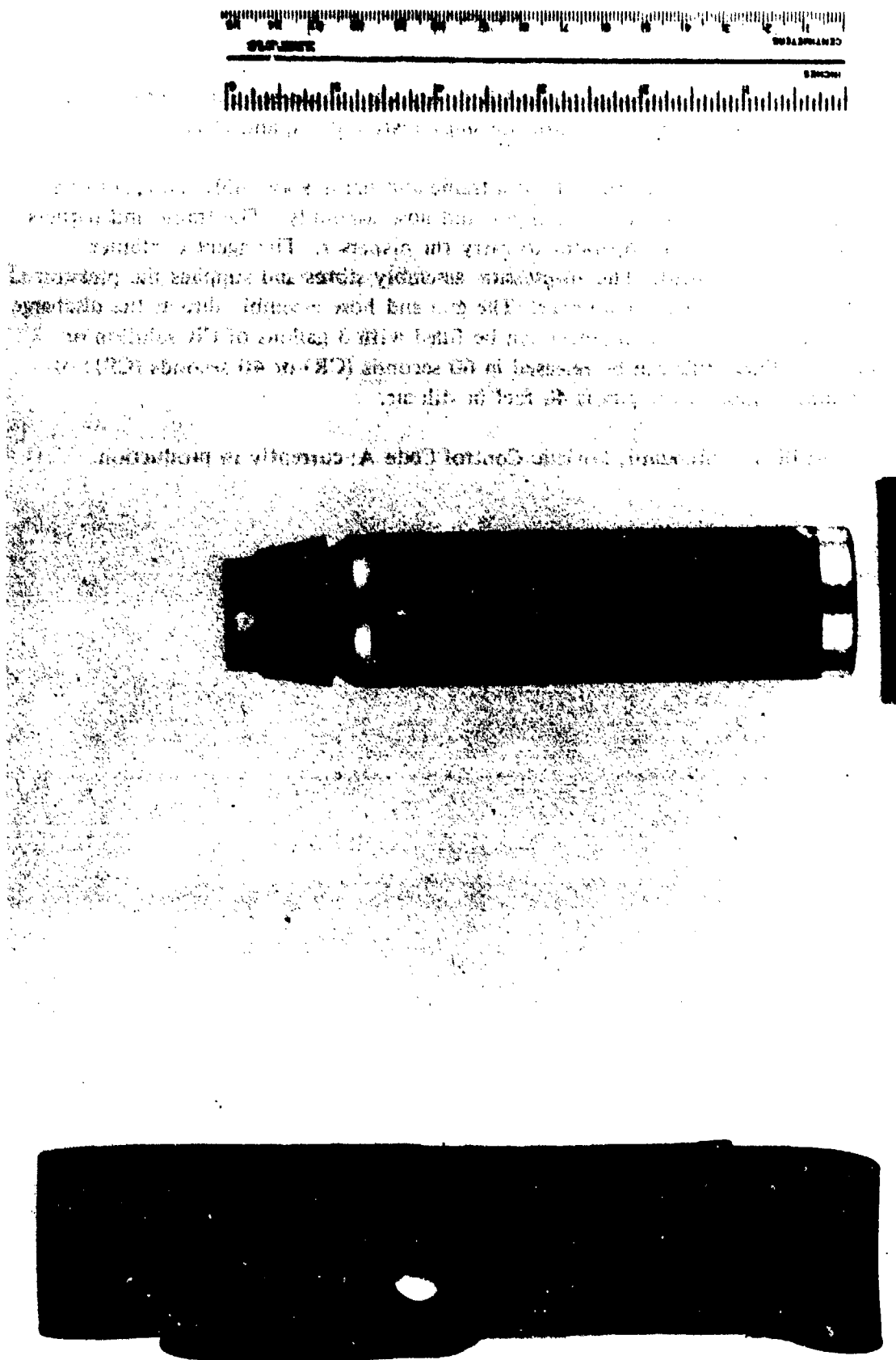


Figure 3. Dispenser and Riot Control Agent, Manually Carried, CR, M36

C. DISPERSER AND RIOT CONTROL AGENT, MANUALLY CARRIED, CR, M36

Use: The hand-held M36 disperser is used to apprehend, control, or subdue (with minimum force) an individual or a small group of individuals who are engaged in illegal acts, such as trespassing, illegal entry, riot, or assault. The purpose of the M36 disperser is individual targeting, which results in minimal contamination of streets, buildings, and surrounding areas.

Description: The M36 disperser consists of a container, valve assembly, and locking actuator. When the disperser is not in use, it is stowed and carried in the carrier assembly.

The container is a round aluminum cylinder which is filled with a solution (65 ml) of CR pressurized with dry nitrogen gas to a pressure of 140 psi at 75°F. A valve assembly contains the mechanism that releases CR agent from the container. A label wrapped around the container includes nomenclature and identification. The disperser is filled with 65 ml of CR solution which can be released in 14 to 24 seconds of continuous operation to a range of 5.5 meters in still air.

Status: Type Classified — Standard; Logistic Control Code A; stockpiled.

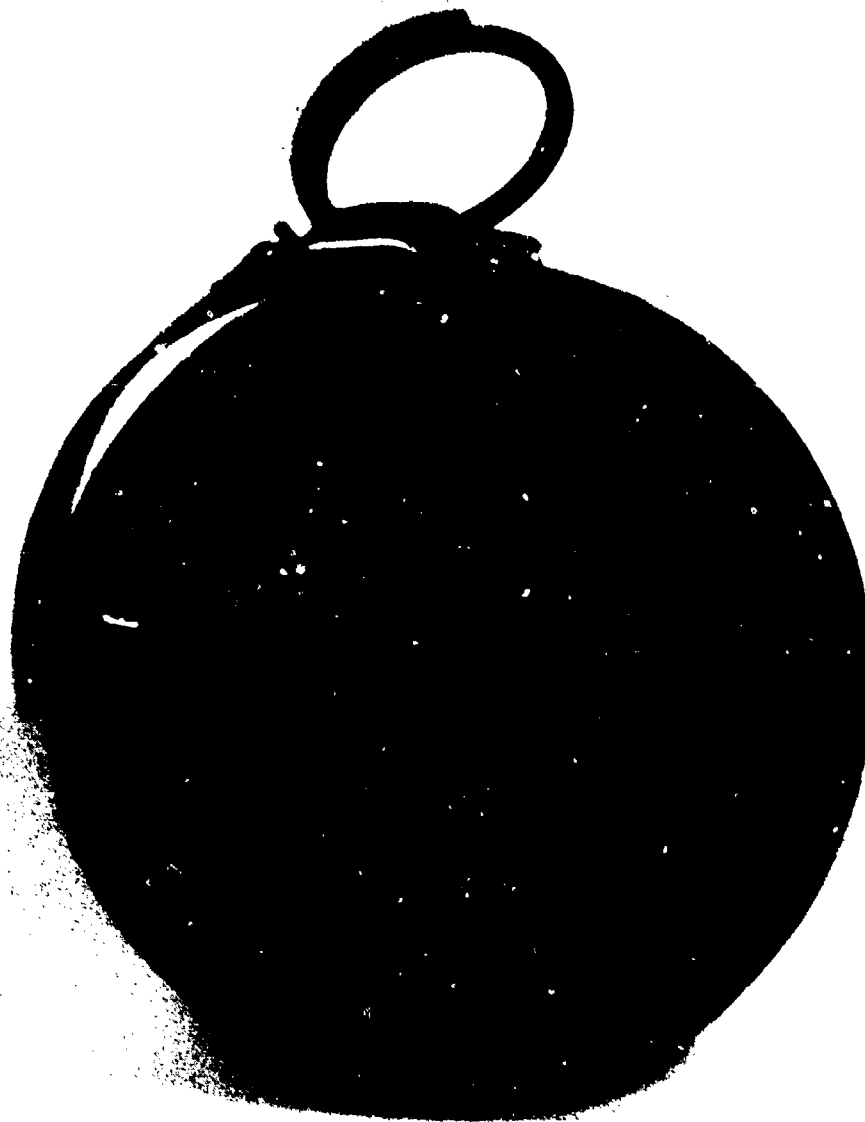


Figure 4. Grenade, Hand, Riot, CS, M47

D. GRENADE, HAND, RIOT, CS, M47

Use: The M47 grenade is a special-purpose, burning-type munition used for control of riots and counterinsurgencies. This grenade is a nonlethal, incapacitating-type munition that contains nonpersistent CS agent.

Description: The M47 grenade consists of a rubber body assembly, an M227 fuze, and a filling of CS pyrotechnic mixture. The grenade weighs 410 grams and is 3½ inches in diameter. The gray grenade body is made of two rubber hemispheres vulcanized together. The top half of the grenade contains the fuze, and the bottom half contains the filling hole and the exhaust port. The grenade is filled with approximately 185 grams of CS-pyrotechnic granulated mix.

NOTE: The M48 red smoke grenade, which is constructed and functions identical to the M47, is used as a training grenade for the M47.

Status: Type Classified – Standard; Logistic Control Code A; currently in production.

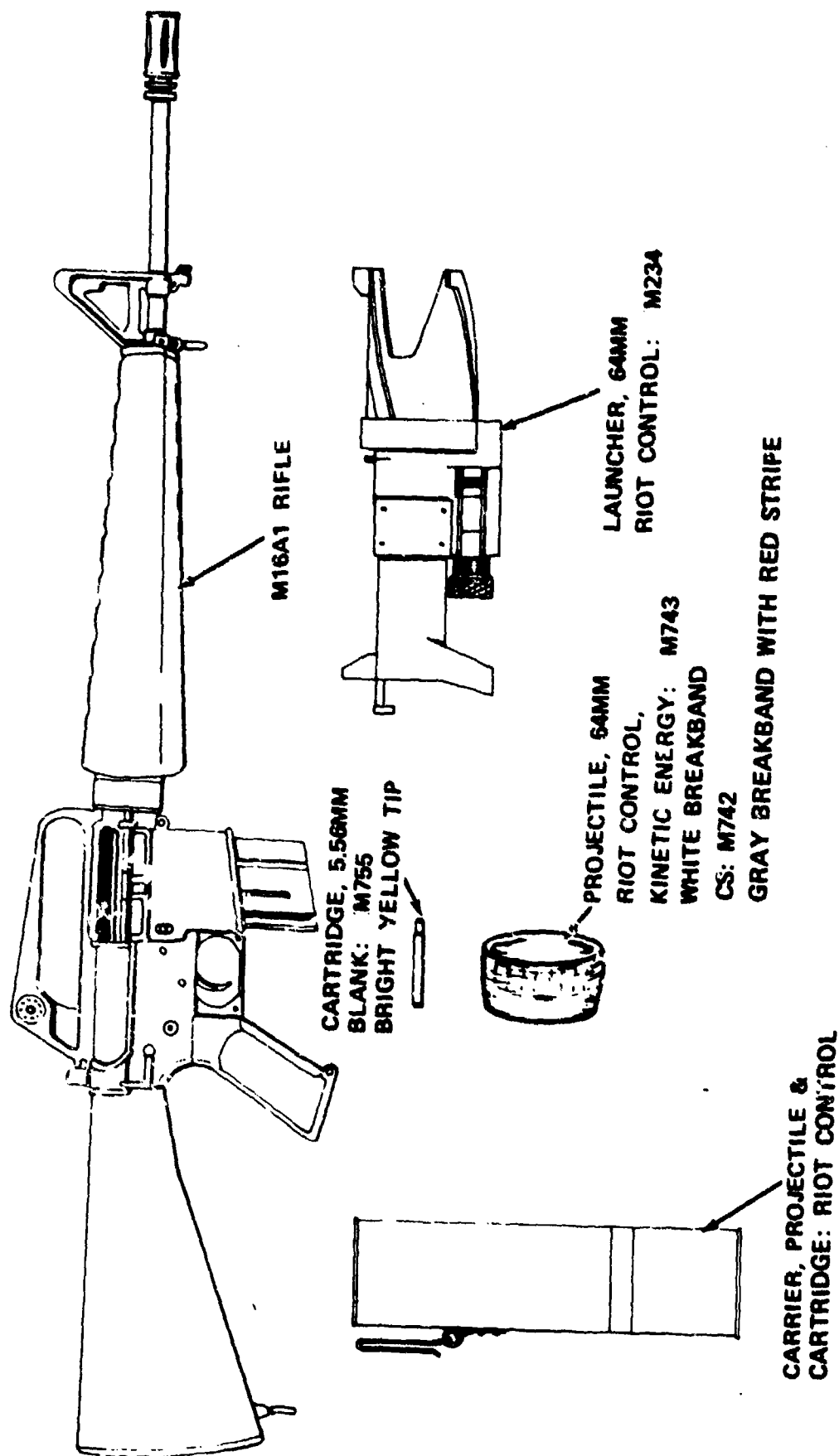


Figure 5. Riot Control Munitions System, 64 mm

E. RIOT CONTROL MUNITIONS SYSTEM, 64-MM

Use: This system launches a kinetic energy projectile that will deter rioters and keep them at a sufficient distance that they could not hit the control forces with thrown rocks or debris. The projectile has sufficient momentum to cause pain and discomfort with a minimum possibility of producing injury to any part of the body. It can also launch a CS-filled projectile intended to augment the kinetic energy projectile, providing a capability of creating a 3- to 5-ft CS cloud on target.

Description: The 64-mm Riot Control Munitions System consists of the Launcher, Projectile, 64-mm, Riot Control, M234; the Projectile, 64-mm, Riot Control, Kinetic Energy, M743 with Cartridge/M755; and, Projectile, 64-mm, Riot Control, CS, M742 with Cartridge/M755. The M234 Launcher is attached to the flash suppressor on the M16A1 rifle. When fired in the rifle, an M755 blank cartridge, which is issued with each projectile, supplies propellant gases to the launcher to propel the projectile at a velocity of about 60 meters per second and a spin rate of about 5000 rpm. The ring airfoil shaping of the 64-mm diameter, 34-gram, soft rubberlike projectile results in a relatively flat trajectory. Each launcher is capable of firing from four to six projectiles per minute. Six projectiles and six blank cartridges are packaged in a fiberboard cylindrical container. The launcher and projectiles will be issued when authorized during civil disturbances where target selectivity and accuracy are important considerations. The velocity is sufficiently high to prevent target personnel within effective ranges from dodging the projectile. The effective range is 40 meters on an individual and 60 meters on groups of individuals, with a maximum range of 100 meters.

Status: Type classified - Standard; Logistics Control Code A; M743 and M234 currently in production, M742 scheduled for FY84 production.



Figure 6. Grenade, Hand, Tactical, CS, M7A3

F. GRENADE, HAND, TACTICAL, CS, M7A3

Use: The M7A3 CS grenade was originally a riot control agent, burning-type grenade used to control riots, mobs, and other disturbances. In 1974, it was determined that this grenade was not suitable for the riot control mission but that it should be retained for tactical purposes only. The M47 grenade, previously discussed in this section, has replaced the M7A3 for the riot control mission.

Description: The M7A3 CS grenade consists of a 2½-inch-diameter cylindrical metal container filled with 9½ ounces of pyrotechnic CS mixture and fitted with an M201A1 grenade fuze which is screwed into an adapter in the top of the grenade. The fuze has a delay of 0.7 to 2 seconds. Three emission holes are located at the top of the grenade; these holes are covered with adhesive tape to protect the filling from moisture. The burning time of the grenade is 15 to 30 seconds.

Status: Type Classified – Standard; Logistic Control Code A; Stockpiled.

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**SECTION III. OTHER US ARMY RIOT CONTROL ITEMS IN THE INVENTORY
(LOGISTIC CONTROL CODES B AND F)**

- A. Cartridge, 40mm: Riot Control CS, M674.**
- B. Disperser and Riot Control Agent, Manually Carried, CSX, M32.**
- C. Disperser, Riot Control Agent, Helicopter- or Vehicle-Mounted, M4.**
- D. Disperser, Riot Control Agent, Portable, M33.**
- E. Disperser, Riot Control Agent, Portable, M3.**

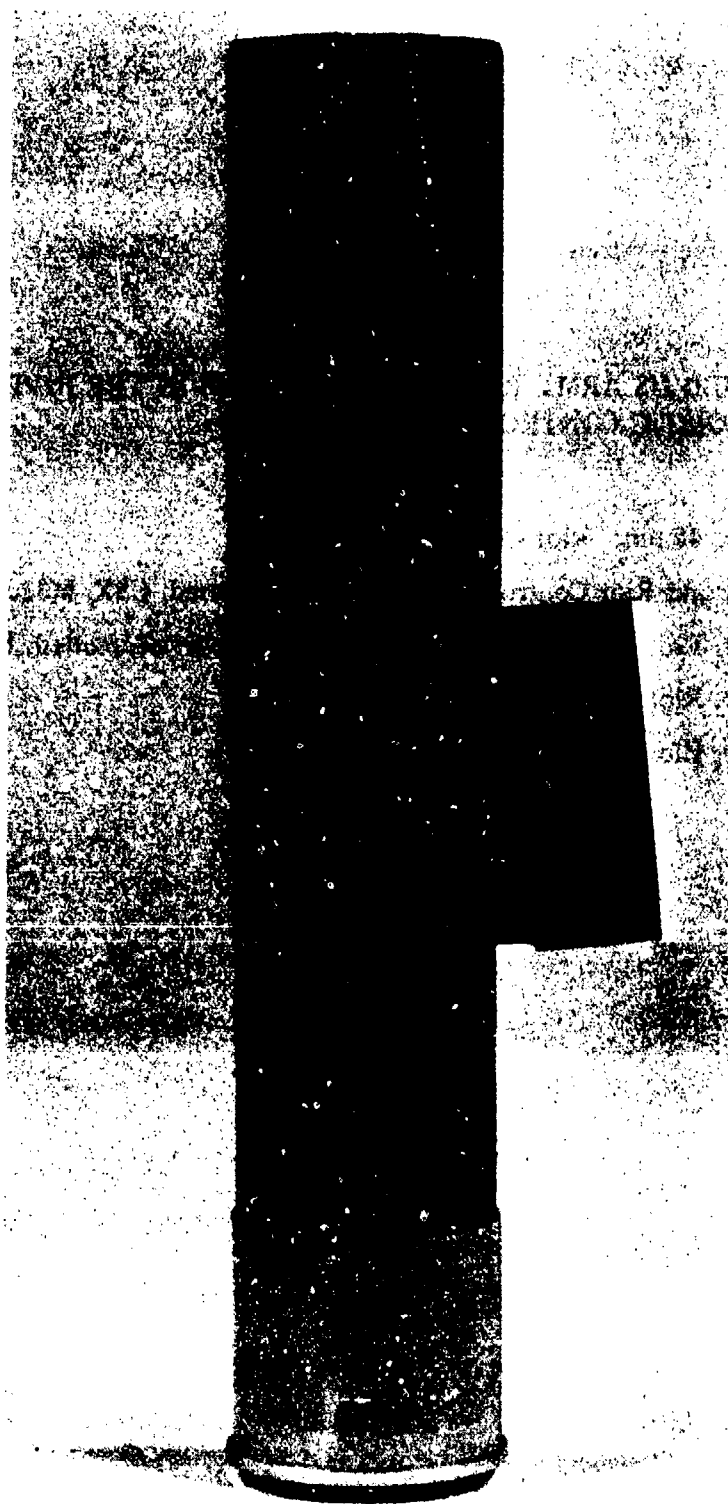


Figure 7. Cartridge, 40mm, Riot Control CS, M674

A. CARTRIDGE, 40MM: RIOT CONTROL CS, M674

Use: The M674 cartridge is used in riot control operations and provides a nonhazardous capability of employing agent CS at ranges beyond those of riot control grenades.

Description: The M674 cartridge is contained in a 38mm-diameter aluminum cartridge case approximately 9 inches long. It can either be fired hand-held or with the M79 grenade launcher or the M8 pyrotechnic pistol. It projects a nonhazardous rubber container, which is filled with 100 grams of CS-pyrotechnic mixture, for a distance of 65 to 90 meters when fired from the M79 or M8 weapons. Lower distances are obtained when hand fired (approximately 45 meters). The container emits CS for approximately 10 to 40 seconds. NOTE: The M675 red smoke cartridge, which is constructed and functions identical to the M674, is used as the training cartridge for the M674.

Status: Type Classified -- Standard; Logistic Control Code B; Stockpiled.



Figure 8. Disperser and Riot Control Agent, Manually Carried CSX, M32

B. DISPERSER AND RIOT CONTROL AGENT, MANUALLY CARRIED, CSX, M32

Use: The hand-held M32 disperser is used to apprehend, control, or subdue (with minimum force) an individual or small groups of individuals who are engaged in illegal acts such as trespassing, illegal entry, riot, or assault. The purpose of the M32 disperser is individual targeting, which results in minimal contamination of streets, buildings, and surrounding areas.

Description: The M32 disperser consists of a container, valve assembly, safety clip, and trigger. The container is a round aluminum cylinder which is filled with a solution of CS pressurized with nitrogen gas to 140 psig at 75°F. A valve assembly releases CS agent through the nozzle. The thumb-operated trigger forms the top of the trigger cover, which fits down over the valve assembly. The safety clip, which is mounted across the top of the trigger, prevents accidental discharge of CS agent when in a locked position. The disperser is encased in a canvas carrier which may be attached to the belt of the operator. The disperser is filled with 60 ml of a trioctyl phosphate solution of CS which can be released in 14 to 20 seconds of continuous operation to a range of 12 feet.

Status: Type Classified — Standard; Logistic Control Code B; very limited stockpile — was replaced by M36 disperser.

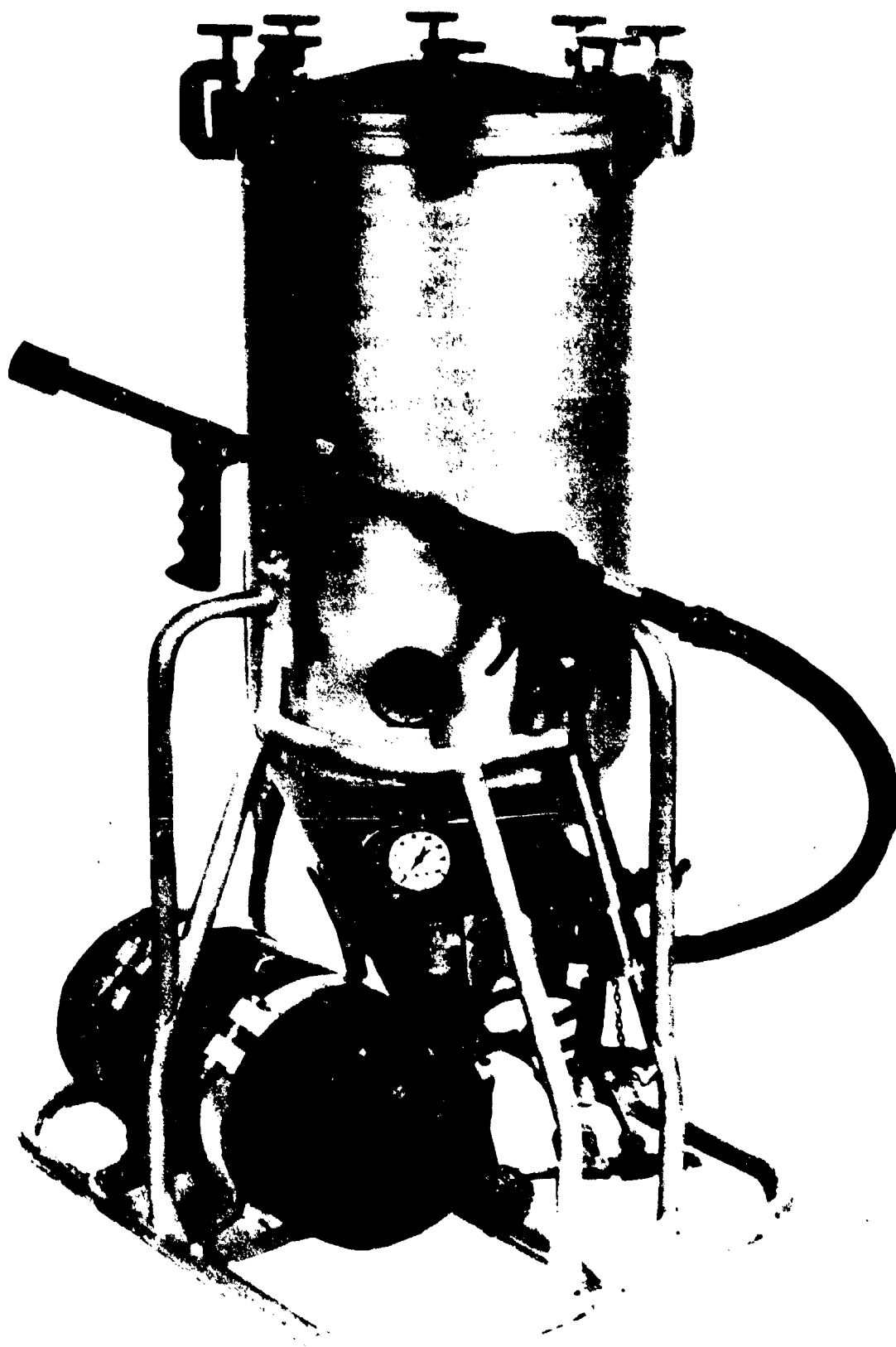


Figure 9. Disperser, Riot Control Agent, Helicopter- or Vehicle-Mounted, M4

C. DISPERSER, RIOT CONTROL AGENT, HELICOPTER- OR VEHICLE-MOUNTED, M4

Use: The M4 disperser disseminates micropulverized riot control agent CS1 from a low-flying cargo helicopter (H-19 or larger) or from a vehicle to disorganize or disperse large disorderly groups.

Description: The major components of the M4 disperser include: an agent tank and frame group, a pressure tank with related gauges and controls, and a discharge apparatus. The discharge apparatus consists of a 10-foot hose, an M9 riot control agent disperser gun (for vehicle mount), and a flexible nozzle (for helicopter mount). The gun and nozzle are interchangeable. Hold-down straps secure the disperser in the helicopter or vehicle. The disperser can be filled with 50 pounds of CS1 which can be released in 2 minutes of continuous operation from the M9 gun or in 20 seconds from the helicopter hose. Range of the gun in still air is 40 feet.

Status: Type Classified — Standard; Logistic Control Code B; Stockpiled.

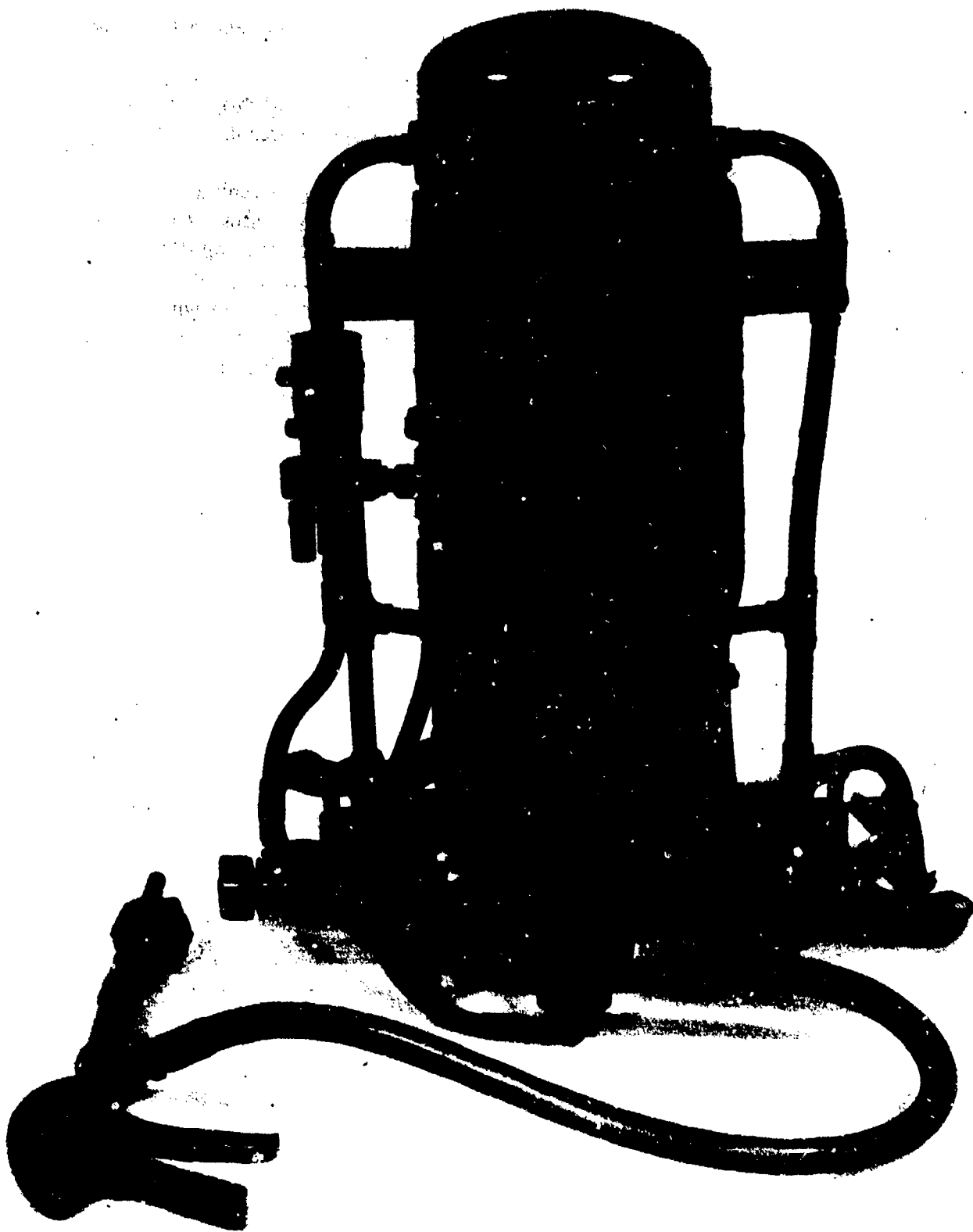


Figure 10. Disperser, Riot Control Agent, Portable, M33

D. DISPERSER, RIOT CONTROL AGENT, PORTABLE, M33

Use: The M33 disperser is used to discharge powdered riot control agent CS1 into the atmosphere to control uprisings, disturbances, and riots.

Description: The M33 disperser has the silhouette of a flamethrower and it consists of an agent tank, an air cylinder, a hose assembly, and a backpack carrier group. The agent tank is pressurized by reduced air pressure from the air cylinder, and the agent is disseminated through the hose assembly and out the nozzle at the end of the hose assembly. The disperser contains 8 pounds of CS1 which can be released in 40 seconds of continuous operation to a maximum distance of 40 feet in still air. The M33, which replaced the M3 disperser, is currently being replaced by the M33A1 disperser.

Status: Type Classified — Standard; Logistic Control Code B; Stockpiled.

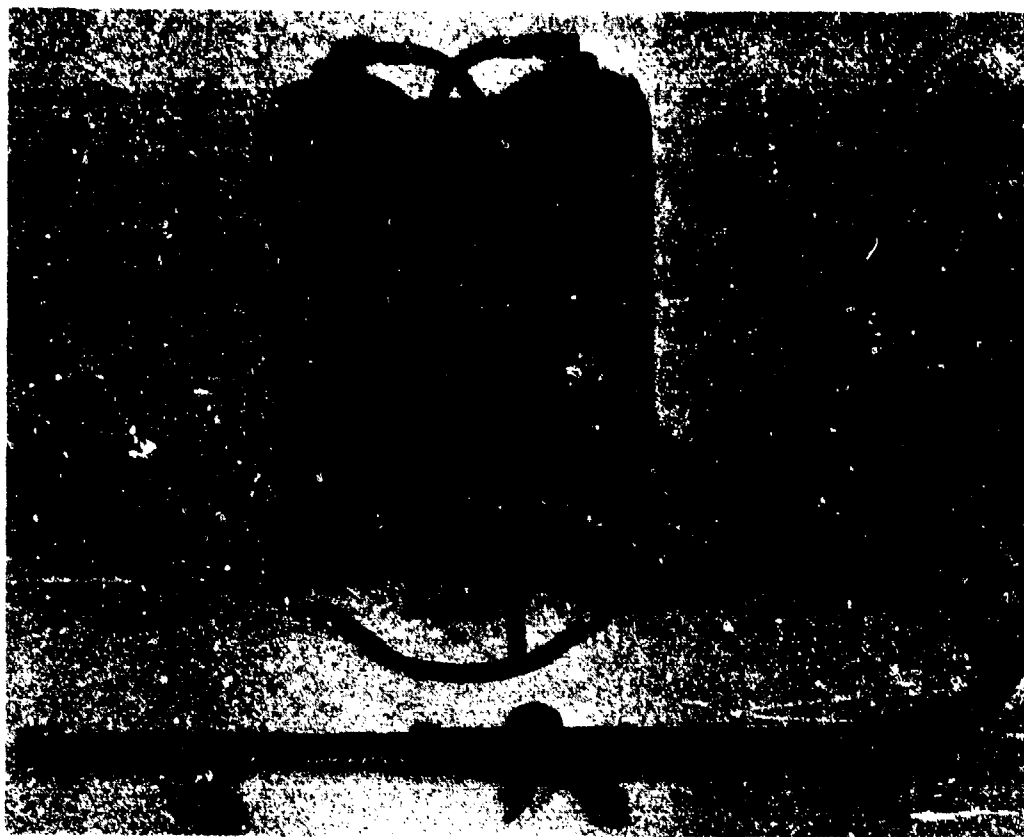


Figure 11. Disperser, Riot Control Agent, Portable, M3

E. DISPERSER, RIOT CONTROL AGENT, PORTABLE, M3

Use: The M3 portable riot control agent disperser is designed to disseminate micropulverized riot control agent CS1 for control of disorderly crowds or riotous disturbances.

Description: The M3 portable riot control agent disperser consists of an M9 portable irritant gas disperser gun connected by an M8 flamethrower fuel hose to a modified M2A1 portable flamethrower fuel and pressure unit. In use, air at 40 ± 5 pounds per square inch forces the agent from the agent tanks and expels the agent from the gun in a cloud. The disperser can be filled with 8 pounds of CS1 which can be released in 20 seconds of continuous operation to a maximum distance of 40 feet in still air.

Status: Type Classified -- Contingency; Logistic Control Code F

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**SECTION IV. US ARMY DEVELOPMENTAL RIOT CONTROL AGENT
CH (EA 4923)**

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CH (EA 4923)

CH (EA 4923) is a liquid, volatile riot control agent. The IC50 is 25 mg/m³. The chemical nomenclature is 1-methoxy-1,3,5-cycloheptatriene. Volatility is 8,484 mg/m³ at 20°C. Onset time of eye effects from vapor is about 40 seconds. The vapor causes eye irritation (closure), skin irritation (pain), and respiratory irritation. Liquid and vapor exposures, though painful, do not produce blisters. Depending on concentration, skin pain may last several hours. The LCt50 for man has not been established, but in all animal species tested the LCt50 is about two times that of CS. At this LCt50, possible lethality is of little concern in its use.

This agent is still under investigation and has not been approved for use in any riot control system.